DEVELOPMENT OF CONTROLLER FOR FRONT COVER ASSEMBLY STATION FOR FLEXIBLE MANUFACTURING SYSTEM USING PLC

Thesis submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Robotic & Automation)

By

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MAC 2008
BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL:
DEVELOPMENT OF CONTROLLER FOR FRONT COVER ASSEMBLY STATION FOR FLEXIBLE MANUFACTURING SYSTEM USING PLC.

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ACKNOWLEDGEMENTS

Alhamdulillah, I’m grateful that by the power of Allah, Most Gracious, Most Merciful, I managed to complete this project. I also want to thank my parents, who taught me the value of hard work by their own example. Both of them are my source of inspiration that lead me to working hard in gaining knowledge. I also would like to share this moment of happiness with all my friends that had help me in completing this project in one way or another.

Foremost I would like to express my sincere gratitude and appreciation to my supervisor, En. Azrul Azwan b. Abdul Rahman who provide me a lot of ideas on how to do and success in this final year project. Finally, I’m also happy to present my gratefully acknowledge to anybody who have helped directly or indirectly in writing this report for their contribution in guidance me finished this report.
ABSTRACT

Flexible Manufacturing System (FMS) has been gaining recognition as an industrial revolution in the 21st century. It is universally applied for factory automation, process control and manufacturing systems, and the most common automation controller that being used in FMS is Programmable Logic Control (PLC). The output relay built in the PLC is provided with various internal contacts in addition to the external output contact. This project present the development of controller an automation station to provide the mechanism to insert the front cover of LCD monitor to join with body of monitor. This project being use SIMATIC S7 as a medium controller for controlling FMS assembly station. The program will be developing to control process sequence and part movement in LCD assembling process. Ladder diagrams (LD) are chosen as program languages to develop sequence in PLC. There are four main phase methodology is applied and will be more presses and absorbed in the methodology flow chart program to ensure the objectives are achieved. The appropriate instruction control programming of this station will be recommended as result, then several suggestion will be recommend from the observation and analysis program developed closely to the project report.
ABSTRAK

Sistem Pembuatan Fleksibel (FMS) telah diberi pengiktirafan sebagai satu revolusi industri dalam abad ke-21. Ianya digunakan secara universal untuk kaedah pengawalan sistem berautomasi, kawalan proses dan sistem pembuatan, dan pengawal automasi yang biasa digunakan dalam FMS adalah Kawalan Logik Boleh Aturcara (PLC). Geganti pengeluaran dibina dalam PLC direka dengan pelbagai sambungan dalaman sebagai tambahan kepada sambungan pengeluaran di sebelah luar. Untuk membangunkan pengawal automasi dan menghasilkan mekanisme pemasangan bingkai hadapan skrin LCD bagi projek ini, kawalan logik program SIMATIC S7 digunakan sebagai medium pengawal untuk mengawal stesen pemasangan. Program yang akan dibina berfungsi untuk mengawal turutan proses dan pergerakan perkakasan dalam proses pemasangan skrin LCD. Rajah tetangga dipilih sebagai bahasa pengaturcaraan untuk menghasilkan turutan dalam PLC. Terdapat empat fasa utama yang digunakan dan ditekankan melalui kaedah carta alir bagi memastikan objektif dapat dicapai. Proses pengaturcaraan kawalan bagi projek ini akan diusulkan sebagai keputusan, seterusnya susulan cadangan daripada pemerhatian dan analisis program mengakhiri laporan bagi pembangunan projek ini.
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<td>FMS</td>
<td>Flexible Manufacturing System</td>
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<tr>
<td>CNC</td>
<td>Computer Numerical Controlled</td>
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<td>FMC</td>
<td>Flexible Manufacturing Cell</td>
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<td>PLC</td>
<td>Programmable Logic Control</td>
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<td>MSDs</td>
<td>Musculoskeletal Disorders</td>
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<td>LCD</td>
<td>Liquid Crystal Display</td>
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<td>CIM</td>
<td>Computer Integrated Manufacturing</td>
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<tr>
<td>CNC</td>
<td>Computer Numerical Control</td>
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<tr>
<td>AC</td>
<td>Alternate Current</td>
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<td>DC</td>
<td>Direct Current</td>
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<tr>
<td>RPM</td>
<td>Revolution Per Minute</td>
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<tr>
<td>DAC</td>
<td>Double Acting Cylinder</td>
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<tr>
<td>SAC</td>
<td>Single Acting Cylinder</td>
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<tr>
<td>I/O</td>
<td>Input Output</td>
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<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
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<tr>
<td>ALU</td>
<td>Arithmetic logic Unit</td>
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<tr>
<td>ROM</td>
<td>Read Only Memory</td>
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<tr>
<td>RAM</td>
<td>Random Access Memory</td>
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<tr>
<td>EPROM</td>
<td>Erasable and Programmable Read Only Memory</td>
</tr>
<tr>
<td>NO</td>
<td>Normally Open</td>
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<td>NC</td>
<td>Normally Close</td>
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<td>CTU</td>
<td>Count Up</td>
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<td>Count Down</td>
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<tr>
<td>HSC</td>
<td>High Speed Counter</td>
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<td>Counter High Speed</td>
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<tr>
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<td>Timer</td>
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<td>TON</td>
<td>Timer On Delay</td>
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<tr>
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<tr>
<td>TOF</td>
<td>Timer Off Delay</td>
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<tr>
<td>TMH</td>
<td>High Speed Timer</td>
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<td>TMS</td>
<td>Super High Speed Timer</td>
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<td>TMRAF</td>
<td>Accumulating Fast Timer</td>
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<td>RTO</td>
<td>Retentive Timer</td>
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<tr>
<td>TMRA</td>
<td>Accumulating Timer</td>
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<tr>
<td>BCD</td>
<td>Binary Code Decimal</td>
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<td>AMC</td>
<td>Advance Manufacturing Centre</td>
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CHAPTER 1
INTRODUCTION

In the middle of the 1960s, market competition became more intense. During 1960 to 1970 cost was the primary concern. Later quality became a priority. As the market became more and more complex, speed of delivery became something customer also needed. A new strategy was formulated: Customizability. The companies have to adapt to the environment in which they operate, to be more flexible in their operations and to satisfy different market segments (customizability). Thus the innovation of FMS became related to the effort of gaining competitive advantage.

First of all, FMS is a manufacturing technology. Secondly, FMS is a philosophy. "System" is the key word. Philosophically, FMS incorporates a system view of manufacturing. The buzz word for today’s manufacturer is "agility". An agile manufacturer is one who is the fastest to the market, operates with the lowest total cost and has the greatest ability to "delight" its customers. FMS is simply one way that manufacturers are able to achieve this agility.

The idea of an FMS was proposed in England (1960s) under the name "System 24", a flexible machining system that could operate without human operators 24 hours a day under computer control. From the beginning the emphasis was on automation rather than the "reorganization of workflow". Early FMSs were large and very complex, consisting of dozens of Computer Numerical Controlled machines (CNC) and sophisticate material handling systems. They were much automated, very expensive and controlled by
incredibly complex software. There were only a limited number of industries that could afford investing in a traditional FMS as described above.

Currently, the trend in FMS is toward small versions of the traditional FMS, called flexible manufacturing cells (FMC). Today two or more CNC machines are considered a flexible cell and two or more cells are considered a flexible manufacturing system. Thus, a FMS consists of several machine tools along with part and tool handling devices such as robots, arranged so that it can handle any family of parts for which it has been designed and developed.

The manufacturing equipment on the shop floor is grouped into manufacturing cells with a programmable controller (most likely) providing direct monitoring, coordination, and control of activities that take place on the equipment within a cell. PLC has been gaining popularity on the factory floor as a programmable controller and will probably remain predominant for some time to come. Most of this is because of the advantages they offer such as cost effective for controlling complex systems, flexible and can be reapplied to control other systems quickly and easily, computational abilities allow more sophisticated control, trouble shooting aids make programming easier and reduce downtime and also reliable components make these likely to operate for years before failure.

PLC is important because all production processes go through a fixed repetitive sequence of operations that involve logical steps and decisions. A PLC is used to control, time and regulate the sequence. Examples of production processes that are controlled using PLCs are metal machining sequences, product assembly lines and batch chemical processes. Logical control has been used to control sequences of actions in automatic manufacturing systems for many years. Originally, a logical control system was ‘hard wired’ using electronic relays, timers and logical units. These systems were inflexible. Once a ‘hard wire’ logic system had been constructed, then if the machining schedule was altered for another type of product, the logic control system had to be manually
rewired for the new application. This was inflexible and time consuming, it restricted the production scheduling of a factory and made changing of product difficult.

![Schematic of a PLC](image)

**Figure 1.1: Schematic of a PLC**

From the figure 1.1 shows that the PLC has 4 main units which is the programme memory, the data memory, the input devices and the output devices. The programme memory is the instructions for the logical control sequence are stored here where it’s will remain once it’s was stored. The data memory is the status of switches, interlocks, past values of data and other working data is stored here. The input devices is the hardware/software drivers for the industrial process sensors such as switch status sensors, proximity detectors, interlock setting and so on while the output devices is hardware/software drivers for the industrial process actuators, such as solenoid switches, motors and valves. All of this main unit will integrate together to made PLC as a controller and produce the process sequence in FMS.
1.1 Problem Statements

In a small company, there are still some of the assembling processes that still being conducted manually. Manual assembling process can take a long time because human will usually be tired doing the same task over and over again. This will result to inefficient work condition. The repetition of these works over long period of time can cause the workers to experiencing lower back pain and in some cases of musculoskeletal disorders (MSDs). In some serious cases, this type of injury can cause the operator to be paralyzes.

Today we also see that the trend toward automation of production equipment is putting great demands on people. The manufacturers have worked to increase productivity, capability, reliability and flexibility by using technologies. In order to achieve these are making use more and more automation in manufacturing. The problem are typically industrial processes in manufacturing where the cost of developing and maintaining the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life.

1.2 Objective / Outcome

The main objective of this project is to develop the programming which controls the sequences of operation for the assembly station using PLC. Additional objective of this projects are:-

a) To do modification in mechanical parts to get complete structure for assembly station.

b) To develop a fully functional assembly station that can be used to assemble front cover of the LCD monitor.
1.3 Scope

In order to design successful FMS workstation system, scopes are required to assist and guide the development of the project. The scope should be identified and planned to achieve the objective of the project successfully on the time. The scopes for this project are:

**Assembly station:**
- Learn the basic operation
- Investigate the structure of input output and pneumatic components involved in this station.
- Identified all connection and relationship between station and PLC.

**PLC**
- Learn and familiarize the PLC program that will be use in this project.
- Investigate and describe the function of each device such as the counter and pulse for motor driver.
- Study the wiring and connection between input output and the PLC.
- Study ladder diagram and block diagram function and learn how to interpret to input and output for assembly station.
- Identified and learn how to minimize the program language to be a simple network program.
- Develop the new program which controls the sequences of operation for the assembly station.
CHAPTER 2
LITERATURE REVIEWS

2.1 FMS

2.1.1 Introduction

Flexibility is the speed at which a system can react to and accommodate change. To be flexible, the flexibility must exist during the entire life cycle of a product, from design to manufacturing to distribution. FMS is a computer-controlled system that can produce a variety of parts or products in any order, without the time-consuming task of changing machine setups. FMS are supposed to provide the manufacturer with efficient flexible machines that increase productivity and produce quality parts. However, FMS are not the answer to all manufacturers problems. The level of flexibility is limited to the technological abilities of the FMS. FMS are being used all over the manufacturing world and though out industries. A basic knowledge of this kind of technology is vary important because FMS are involved in almost everything that you come in contact with in today's world. From the coffee maker to your remote control FMS are used all over (Thompson, 1993).
2.1.2 History of FMS

At the turn of the century FMS did not exist. There was not a big enough need for efficiency because the markets were national and there was no foreign competition. Manufacturers could tell the consumers what to buy. Henry Ford is quoted as saying “people can order any color of car as long as it is black.” This was the thinking of many big manufacturers of the time. After the Second World War a new era in manufacturing was to come. The discovery of new materials and production techniques increased quality and productivity. The wars end open foreign markets and new competition. Now the market focused on consumer and not the manufacturer. The first FMS was patent in 1965 by Theo Williamson who made numerically controlled equipment. Examples of numerically controlled equipment are like a CNC lathes or mills which is varying types of FMS. In the 70’s manufacturers could not stay to date with the ever-growing technological knowledge manufacturers competitors have, so FMS became mainstream in manufacturing. In the 80’s for the first time manufacturers had to take in consideration efficiency, quality, and flexibility to stay in business (Maleki, 1991).

2.1.3 Benefits of Flexible Manufacturing

A major benefit to FMS is that it can fluctuate as the market fluctuates. FMS can be changed to produce more or less depending on the need. This characteristic is one that many manufactures seek out when trying to develop a product. Also, when a manufacturer is looking to expand, FMS can expand with the manufacturer. As time changes and new technologies are developed FMS can change with them.
Below is a list of benefits for using FM systems:

**Short-term Changes**

a) Engineering changes,  
b) Processing changes,  
c) Machine unavailability, and  
d) Cutting tool failure.

**Long term Changes**

a) Changing product volumes,  
b) Different part mixes, and  
c) New Product additions.

For many manufacturers and industrial companies, FMS is expensive to purchase and install. For the most part, to install FMS is a multimillion dollar investment. Besides the installation of the FMS the training of the people working on the FMS can be complex. So because of the cost of these systems the manufactures that use them are very specialized (Dunlap, 1984).

### 2.1.4 Development of FMS

Several actions must be decided on before you can have a FMS. These actions include.

a) Selecting operations needed to make the product.  
b) Putting the operations in a logical order.  
c) Selecting equipment to make the product.  
d) Arranging the equipment for efficient use.  
e) Designing special devices to help build the product.  
f) Developing ways to control product quality.